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Electrical controlled swing-type permanent magnet driving motor

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ABSTRACT

To complete the rotational motion of permanent magnet (PM) driving motor with its own magnetic energy, magnetic force, generated torque by using the help of electrical controlled swing-type device. The electrical controlled swing-type motor is made and designed by referring to the professor Hong's invention patient of swing-type PM motor fan in 2019 that actuated by the two PM rotators and one PM stator. The electrical controlled swing-type PM driving motor consists of a supporter frame base, a rotator module, a stator module, a gear module and electrical controlled swing-type device. The important of PM driving motor might be contributed to the green energy technique in the motor fan mechanical innovation design. The electrical controlled swing-type PM driving motor can be actuated to produce completely rotation with its own magnetic energy and kinetic energy in automobile from the swing motion of electrical controlled swing-type device.

Keywords: swing-type; PM driving motor; rotator; stator; green energy

1. INTRODUCTION

Under the impact of global warming and greenhouse effect, reducing energy and carbon consumption is an important issue. In product designs, people also pursue energy-saving as a goal, in the hope of making full use of the products while reducing as much

as possible the use of electricity. Early fans and motors directly driven by electrical power have the problem of large power consumption. Recently, there are also fans and motors driven by piezoelectric actuators. In 1997, Uchino presented the piezoelectric actuators to adjust the motions of positioner, motor and damper for the micro-displacement transducers. In 2010, Choi and Han presented the piezoelectric actuators to control the applications of smart materials. In 2018, Shevtsov et al. presented the modeling of mathematical and experimental in piezoelectric actuators and generators for the energy harvesting. They have the advantages of low voltage, free from noise interference, small size, fast response, less heat, good precision, high conversion efficiency and easy control. The piezoelectric actuator-driven fan and motor works by generating energy waves by inputting electrical energy, thereby deforming the metal disc of the piezoelectric actuator to generate an actuating force for driving the motor. There are some type of permanent magnet (PM) motor and fan used in the application fields. In 2010, Gieras presented the application of PM electric motors for industry, public life, domestic life, information and office equipment, automobiles with combustion engines, transportation, defense forces, aerospace, medical and healthcare equipment, power tools, renewable energy systems, also for the research and exploration equipment. In 2010, Krishnan presented the control application of PM synchronous motor (PMSM) and brushless direct current (DC) motor (BLDCM) drives for the cost minimization of controller in the converters and the machines. In 2012, Xia presented the control and drive application of BLDCM for elevator door control system and traction machine system, inverter air conditioner, also for the electric vehicles and bicycles. Usually the direction of current in the electric motors is controlled by the brush or brushless converters to produce the torque and complete the rotations of shaft. The torque is provided from the reactions of circumference in the conventional armature. The direction of current usually changed many times in one rotation of shaft to maintain torque continuously. In 2013, Gu et al. presented the algorithms of control circuit of field oriented control (FOC) used in the driving and braking control of the in-wheel PMSM to reduce the torque ripple.

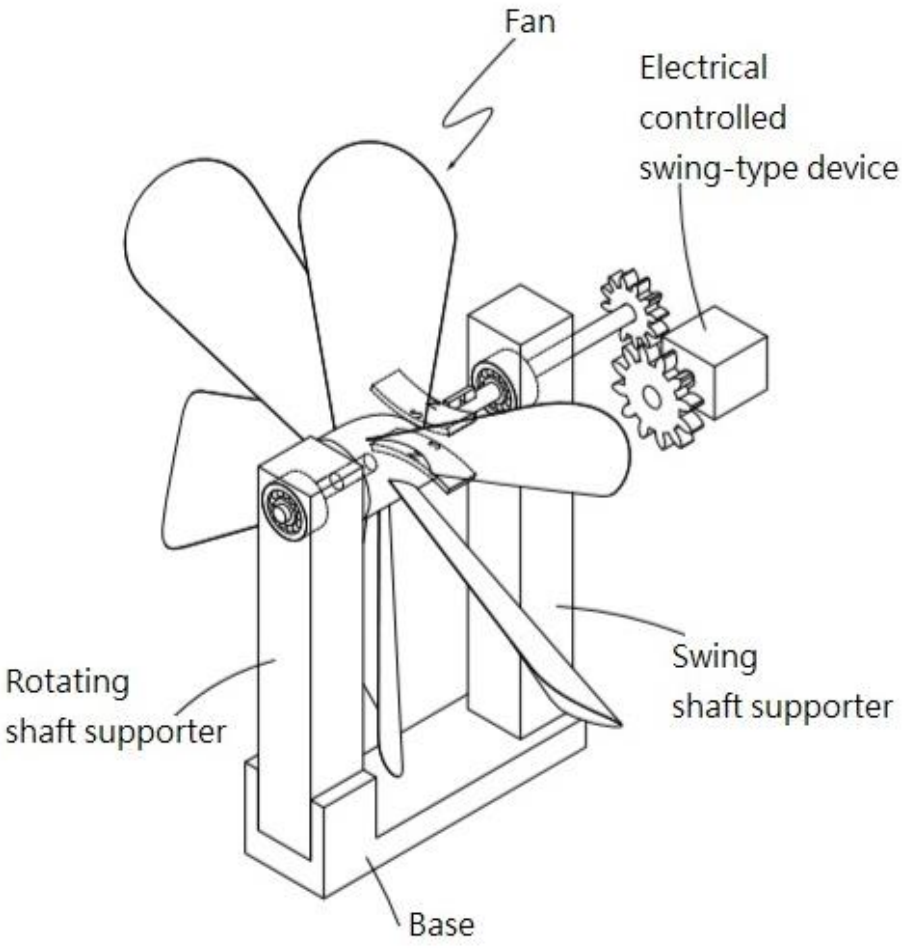

Figure 1 Installation of an electrical controlled swing-type permanent magnet driving motor

The above is the current usage of the actuators and motors. However, the actuator-driven motors have their limited range of uses and their own advantages and disadvantages. In 2019, Hong and Tsai presented an application of rotating arms type PM motor without any wiring. It could be improved in the work with an electrical controlled swing-type device to help and control the complete rotation. The inventor of this invention upholds many years of experience in the design, development and actual production of the related field. It is an objective of the invention to provide an electrical controlled swing-type PM driving motor which is different from the conventional armature above-mentioned motors in structure and utilizes the principle of magnetism in order to have a better performance. The torque is provided directly from the reactions of magnetism forces in the shaft end. The direction of torque usually continuous maintained only one time in one rotation of shaft. The invention has a wide range of applications. It can effectively reduce the demand for electricity use, and reduce the cost of electricity consumption in order to achieve the effects of low energy consumption and structural stability.

2. DESIGN AND CONSTRUCTION

New design and application of electrical controlled swing-type PM driving motor are developed and constructed as shown in Fig. 1. The electrical controlled swing-type PM driving motor comprises a supporter frame base, a rotator module, a stator module, a gear module and electrical controlled swing-type device. The supporter frame base provides the shaft support for rotating shaft, swing shaft and electrical controlled swing-type device. The diameter of rotating shaft is 5mm; the diameter of swing shaft is 4.98mm. The location of PM rotators, PM stator and gear module in the swing-type PM motor are shown in Fig. 2. The PM stator is allowed to have small move in swing motion and locate at the side of rotating shaft end. The rotator module comprising two PM rotators, fan and a fan central bracket to provide the completely rotation motion (as an output for the PM driving motor) as shown in Fig. 3. The stator module comprising one PM stator, a swing shaft and a small gear. The study data of simulation and experimentation for the locations with respect to *x*, *y* and *z* axes of thin PM stator ring piece and thin PM stator ring piece used in the PM motor is presented by Hong and Tsai in 2019. The gear module comprising the big and small gears to provide the speed increasing rate for the forward and backward in 15 degree of swing motion (as an input for the PM driving motor). The swing motion is provided in automobile by the electrical controlled swing-type device with a servo motor and a programmable controlled board.

Near the top of the stator swing shaft supporter is formed with a first shaft hole and a first bearing hole. The first bearing hole is provided with a first bearing. Near the top of the rotating shaft supporter is formed with a second shaft hole and a second bearing hole. The second bearing hole is provided with a second bearing. The electrical controlled swing-type device is provided with a servo motor, an active gear, a passive gear, a swing shaft, and a supporter. The passive gear is connected with a stator, whose one end is provided with an engaging groove. The engaging groove is fixed with a PM stator ring piece (NS poles, arc length 11mm, height 10mm). The servo motor is connected with the active gear. The diameter of the active gear is greater than that of the passive gear, so that they together have a speed-changing effect. The rotating fan central bracket is provided with an axial block (diameter 25mm) whose center is formed with an axial hole. The axial hole is penetrated with a rotating shaft. The upper and lower sides of the end surface on one side of the axial block bracket are provided in groove with a PM rotator ring piece (NS poles, arc length 30mm, height 10mm), respectively. The PM stator ring piece is disposed between the swing shaft supporter and the rotating shaft supporter. The rotating shaft of the axial hole on the axial block of the rotating fan central bracket penetrates through the second shaft hole formed on the rotating shaft supporter on the supporter frame base. The end part of the rotating shaft is fixed onto the second bearing in the second bearing hole corresponding to the second shaft hole. The PM rotator ring piece on the rotating fan central bracket is disposed between the PM stator and the rotating shaft supporter. The PM stator ring piece and the PM rotator ring piece are disposed with the same pole facing each other. Electrical power drives the servo motor of electrical controlled swing-type device to rotate the active gear by swinging forward and backward. The active gear is connected with the passive gear so that the stator also rotates by swinging forward and backward more quickly. The PM stator ring piece and the PM rotator ring piece on the rotating fan central bracket repel each other by the same pole then attract each other by the opposite pole during the swing motions. The PM rotator shell piece of the fan central bracket generates a torque due to the magnetic exclusion force and attraction force then rotates the rotating shaft.

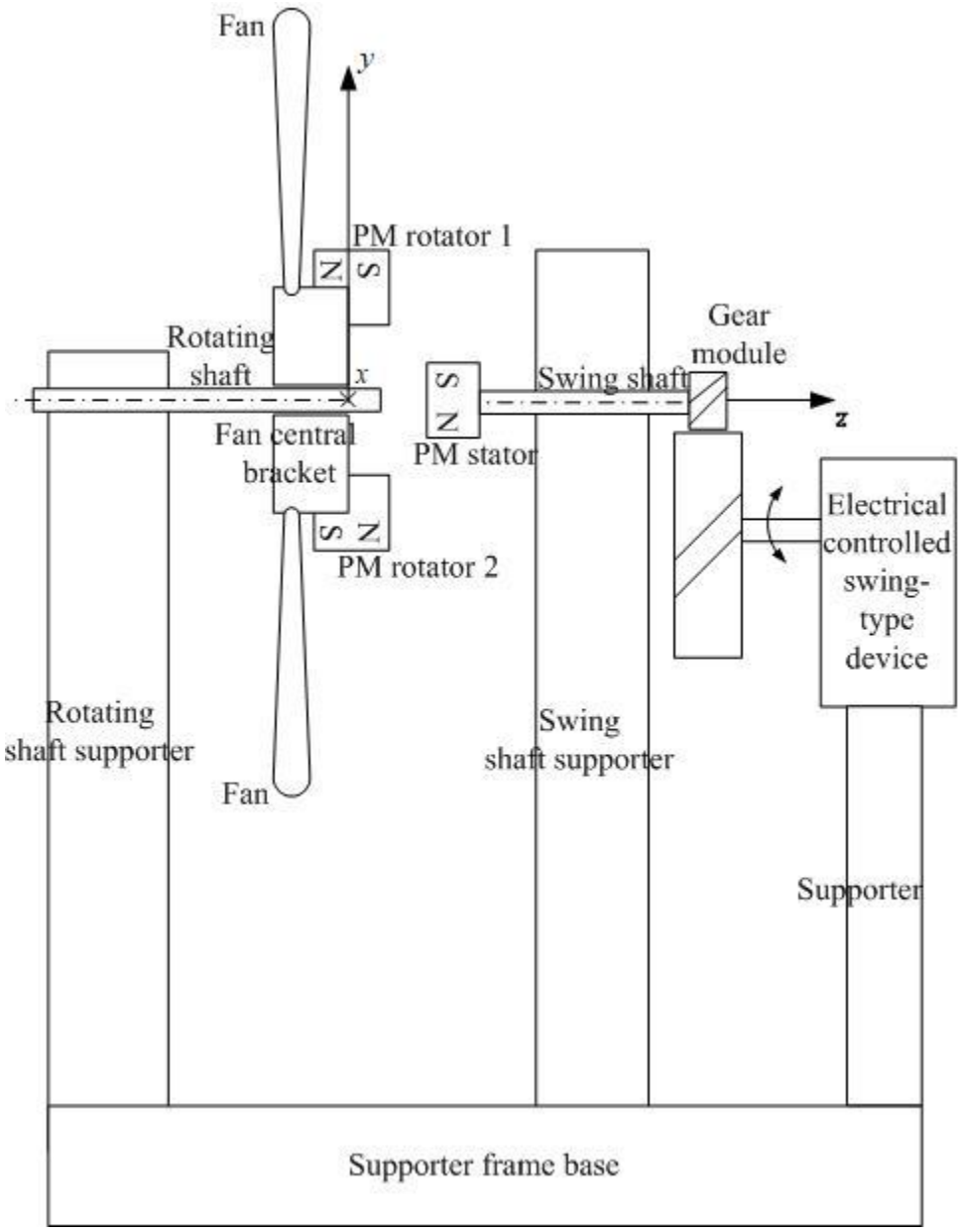

Figure 2 Location of PM rotators, PM stator and gear module in the swing-type PM motor

3. RESULTS AND DISCUSSION

In this paper did not use any international standard tests for the experimentation, only used personal investigation view to find the preliminary data. The two ring piece of PM rotators with 30mm arc length, 10mm height and 2mm thickness thin PM are placed nearly with opposite poles (N pole, S pole) embedded half into the fan central bracket. The one ring piece of PM stator with 11mm arc length, 10mm height and 2mm thickness thin PM is placed at the proper position away from the right end of rotating shaft. The material of PM is N45H (sintered neodymium-iron-boron). The PM driving motor can be actuated to produce completely rotation with its own magnetic energy and kinetic energy from the swing motion provided in automobile by using the electrical controlled swing-type device. The swinging program of forward and backward motion is written by a open Arduino software into UNO microcomputer to control and provide swinging in automobile. The gear modular ratio is 1.5 used for the gear module, the gear amount of big gear is 47 and small gear is 10, the diameter of the pitch circle of big gear is 70.5mm and small gear is 15mm. The experimental data for the rotating shaft rotation speed (rpm) vs. volt (V) of servo motor is shown in Fig. 4. The rotation speed of rotating shaft is increasing with the volt of servo motor. When the volt is 5V, the rotation speed 101rpm is found. The experimentation for the electrical controlled swing-type PM driving motor can be actually worked to produce completely rotation

with its own magnetic energy and kinetic energy in automobile from the swing motion of electrical device. In the future work, the similar kinetic energy in nature comes from the swing of ocean wave, river wave and Lake Wave would be studied.

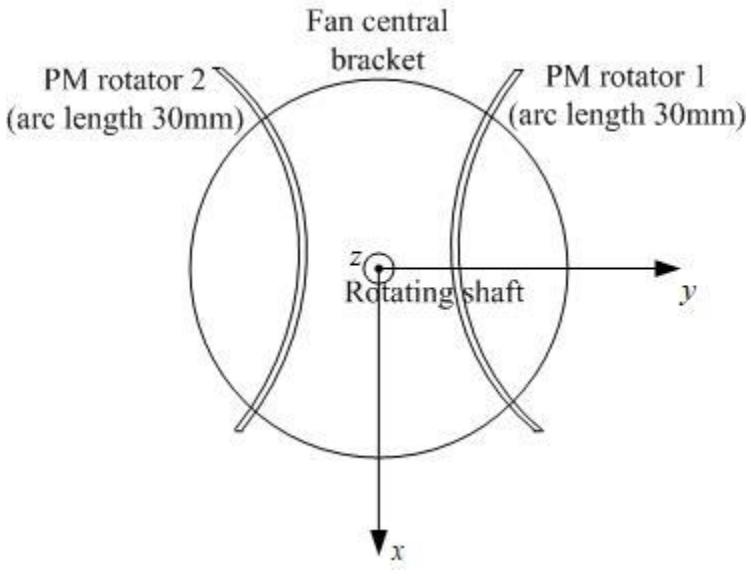

Figure 3 Installation of a rotator module

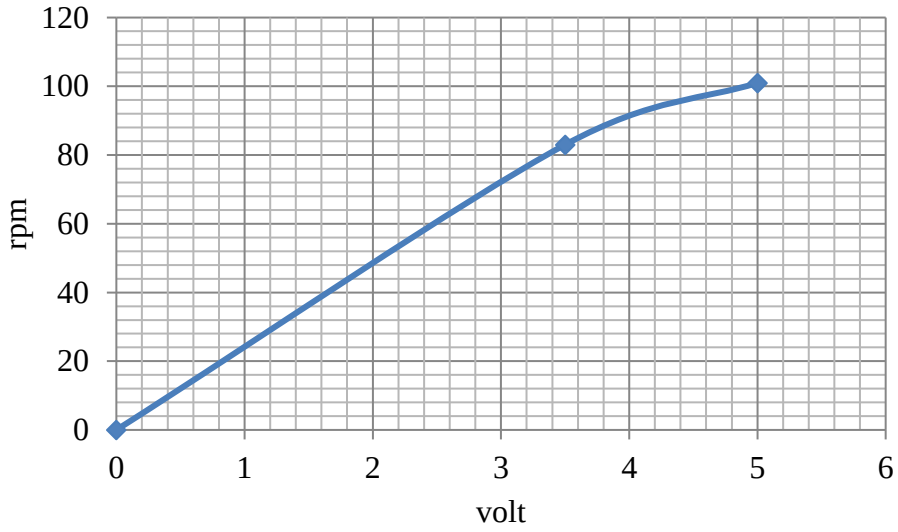

Figure 4 The rotating shaft rotation speed (rpm) vs. volt (V) of servo motor

4. CONCLUSION

The important of swing-type PM driving motor might be contributed to the green energy technique in the motor of mechanical innovation design and construction by using the nature power, e.g. the swing motion of ocean wave.

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Conflicts of Interest: The authors declare no conflict of interest.

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